

**What is claimed is:**

1           1. An apparatus, comprising  
2           a chuck;  
3           a plurality of precision ferrules, each having at least one hole therethrough;  
4           a plurality of optical fibers;  
5           wherein said chuck holds said precision ferrules in an array with hexagonal  
6           packing and an end of each of said fibers is bonded within a respective one of said holes.

1           2. The invention as defined in claim 1 wherein said apparatus is optically coupled  
2           to a corresponding other hexagonally packed array.

1           3. The invention as defined in claim 2 wherein said other hexagonally packed  
2           array is one of the group consisting of a micro electromechanical system (MEMS) having  
3           a hexagonal array of micro mirrors, a hexagonally packed array of photo detectors, a  
4           hexagonally packed array of light sources.

1           4. The invention as defined in claim 1 wherein said chuck is fabricated to include  
2           at least one flexible member.

1           5. The invention as defined in claim 1 wherein said holes of said ferrules have an  
2           average deviation from the correct positions of less than 3  $\mu\text{m}$ .

1           6. The invention as defined in claim 1 wherein said holes of said ferrules have a  
2           collective displacement of less than 3  $\mu\text{m}$ .

1           7. The invention as defined in claim 1 wherein said holes of said ferrules have an  
2           average angular misorientation of 3.9 or less degrees.

1           8. The invention as defined in claim 1 wherein said fibers are bonded within said  
2           holes using glue.

1           9. The invention as defined in claim 1 wherein said ferrules are arranged to be  
2 perpendicular to a face of said chuck.

1           10. The invention as defined in claim 1 wherein said ferrules are arranged at an  
2 angle to a face of said chuck.

1           11. The invention as defined in claim 1 wherein said chuck has a hexagonal  
2 opening within which said precision ferrules are held in said array with hexagonal  
3 packing.

1           12. The invention as defined in claim 1 wherein at least one of said ferrules has  
2 an end with a conical tip.

1           13. The invention as defined in claim 1 wherein at least one hole of said ferrules  
2 has at least one conical entrance.

1           14. The invention as defined in claim 1 wherein each of a subset of at least two  
2 of said fibers has a terminating end that is substantially flush with one end of the one of  
3 said ferrules into which said fiber is inserted, and said terminating end of all of fibers said  
4 subset being substantially coplanar.

1           15. The invention as defined in claim 14 wherein at least one of said fibers has a  
2 terminating end that not is substantially coplanar with said terminating ends of said  
3 subset of said fibers.

1           16. The invention as defined in claim 1 wherein said precision ferrules are at least  
2 two millimeters long.

1           17. The invention as defined in claim 1 wherein said precision ferrules are  
2 ceramic.

1           18. The invention as defined in claim 1 further comprising at least one additional  
2 ferrule wherein the hole of said at least one additional ferrule does not have an optical  
3 fiber bonded therein, said hole of said at least one additional ferrule that does not have an  
4 optical fiber bonded therein being adapted to align said apparatus to a further device to  
5 which said apparatus is coupled.

1           19. The invention as defined in claim 1 further comprising a layer of a non-rigid  
2 material interposed between said chuck and said ferrules that abut said chuck, said  
3 material being non-rigid with respect to said chuck and said ferrules,

1           20. The invention as defined in claim 19 wherein said non-rigid material is at  
2 least one of the group consisting of plastic, polyester, polyimide.

1           21. The invention as defined in claim 1 further comprising at least one additional  
2 ferrule that does not contain a fiber end.

1           22. The invention as defined in claim 1 further comprising at least one additional  
2 ferrule, said at least one additional ferrule containing an alignment member protruding  
3 therefrom.

1           23. The invention as defined in claim 1 further comprising a reinforcing sleeve  
2 coupled to said chuck.

1           24. The invention as defined in claim 1 further comprising a reinforcing sleeve  
2 integrated with said chuck.

1           25. The invention as defined in claim 1 further comprising glue in the interstices  
2 between said ferrules which acts to couple said ferrules to each other.

1           26. The invention as defined in claim 1 wherein a face of said apparatus at which  
2 said ends of said fibers protrudes is polished.

1           27. The invention as defined in claim 1 wherein said fibers are cleaved fibers.

1           28. The invention as defined in claim 1 wherein said chuck has mounting holes  
2 within it which are adapted for mounting said apparatus to a further device to which said  
3 apparatus is coupled.

1           29. A method for making a precision fiber array, the method comprising the steps  
2 of:

3           securing a plurality of precision ferrules arranged with hexagonal packing in a  
4 chuck, each of said ferrules having at least one hole therethrough;

5           inserting a respective optical fiber end into the hole of each of a plurality of said  
6 ferrules; and

7           bonding each of said optical fiber ends to its respective one of said plurality of  
8 ferrules.

1           30. The invention as defined in claim 29 wherein said chuck has an interior space  
2 in which said ferrules are secured, said securing step further comprising the steps of:

3           heating said chuck to expand its interior space; and

4           inserting said plurality of precision ferrules within said interior space while it is at  
5 least somewhat expanded as a result of said heating step.

1           31. The invention as defined in claim 29 further comprising the step of bonding  
2 each of said precision ferrules to each other.

1           32. The invention as defined in claim 29 further comprising the steps of:

2           bonding each of said precision ferrules to each other; and

3           removing said chuck.

1           33. The invention as defined in claim 29 further comprising the step of polishing  
2 said optical fiber ends.

1           34. The invention as defined in claim 29 further comprising the step of aligning  
2 said optical fiber ends with an optical flat prior to performing said bonding step.

1           35. The invention as defined in claim 29 further comprising the step of coupling a  
2 reinforcing ring to said chuck.

1           36. The invention as defined in claim 29 further comprising the steps of:  
2           securing in said chuck at least one additional precision ferrule having at least one  
3 hole therethrough; and  
4           bonding an alignment member into said at least one hole of said at least one  
5 additional ferrule so that a portion of said alignment member protrudes from said at least  
6 one hole of said at least one additional ferrule.

1           37. The invention as defined in claim 29 further comprising the step of securing  
2 in said chuck at least one additional precision ferrule having at least one hole  
3 therethrough into which one of said fiber ends is not inserted.

1           38. An apparatus, comprising:  
2           a plurality of precision ferrules tightly held together to form an array with  
3 hexagonal packing, each of said ferrules having at least one hole therethrough; and  
4           at least two optical fiber ends being bonded within the holes of respective ones of  
5 said ferrules.

1           39. The invention as defined in claim 38 wherein said precision ferrules are held  
2 together by glue.

1           40. The invention as defined in claim 38 wherein said precision ferrules are held  
2 together by a chuck.

1           41. The invention as defined in claim 38 wherein said apparatus is arranged so  
2           that said optical fiber ends are pointing in substantially exactly the same direction.

1           42. The invention as defined in claim 38 further comprising at least one  
2           additional ferrule having at least one hole therethrough, wherein said hole of said at least  
3           one additional ferrule does not have an optical fiber end bonded therein, said hole of said  
4           ferrule that does not have an optical fiber end bonded therein being adapted to align said  
5           apparatus to a further device to which said apparatus is coupled.

1           43. The invention as defined in claim 38 further comprising at least one  
2           additional ferrule having at least one hole therethrough, wherein said hole of said at least  
3           one additional ferrule has an alignment member bonded therein and protruding therefrom  
4           so as to be adapted to align said apparatus to a further device to which said apparatus is  
5           coupled.

1           44. The invention as defined in claim 38 further comprising at least one  
2           additional ferrule having at least one hole therethrough, wherein said hole of said at least  
3           one additional ferrule is adapted to receive an alignment member whereby said apparatus  
4           is aligned to a further device to which said apparatus is coupled.